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The development of height and weight measuring instruments for web-based Anthropometric tests

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Abstract

Early childhood talent identification sport programs are needed to decide the potential of children in certain sports. It is expecting that children will be able to maximize sports achievements according to their talents. To find out a human's talent in sports, several parameters can be used for a measurement. One of them is the anthropocentric test, which is a series of processes for measuring the dimensions of the human body with in the form of body height and weight. Based on the results of measurement analysis, children will be able to identify their sport talents. Therefore, a website-based height and weight measurement system was developed that is able to provide information on measurement results and talents identification. The development of this tool uses the ESP 32 Dev Kit Module as a micro controller, an ultrasonic sensor for height sensors and a load cell for a weight sensor. The data are sent to the database contained on the website for further processing and analysis based on the measurement results of talent in the sports field. The measurement website page can display measurement results and identify type of talent that belongs to the child. Based on the results of measurement and data analysis, the accuracy of the tools for measuring body height were 98.7% and body weight were 99.5%, while the precision of the tools were 98.6% for body height and body weight were 97.4%.

Keywords: Anthropometry, ESP 32 Dev Kit Module, Talent Identification, Website.

1. Introduction

Children are born into the world with a variety of natural potentials, personalities and talents. One of those talents is in the field of sports[1]. Parents can direct and guide their children to develop their potential with identifying their children's talents as early as possible. Before beginning the training phase aimed at achieving high achievement, an early childhood talent identification program is needed[2]. The anthropometric test is one of several parameters that can be used to determine a child's sport abilities. Anthropometry can be used as a measure to determine which sports are optimal for high performance growth[3].

Anthropometry is the science of measuring the proportions of the human body in terms of features, structure, and scale. Anthropometric scales are height and weight measurements dependent on anthropometric studies[4]. Anthropometric measurement analysis plays a very important role in the aid of certain sports, as it has an impact on performance. This is because anthropometric measures that are appropriate for the style of sport can have an effect on athletic success, and will be used to create an exercise program optimal for the sport.

Based on studies published by Kartjin (2015) in his research journal Anthropometric Characteristics, Physical Fitness, and Motor Coordination of 9 to 11 Years Old Children Participating in a Wide Range of Sports, the anthropometric test was used to group multiple sports groups based on several measurement tests used to determine children's skills in the field of sports. Anthropometric tests, according to his journal, will indicate what physical features are best for a specific sport. Table 1 displays the absolute values of anthropometric measurements of height and weight for children aged 9 to 11 years for each of various sports.

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Anthropometric measurement test techniques usually necessitate a number of instruments, including height and weight measuring instruments. Measuring and recording measurement results are also performed manually and independently in most cases. As a result, it takes a long time and is considered inefficient. As a matter of fact, it is important to develop an automated measurement instrument for height and weight to optimize the anthropometric testing method.

Table 1. Specification sport based an anthropometric value

Sports	Body Height (cm)	Body Weight (kg)	BMI ($kg.m^{-2}$)
Basketball	143,60±7.60	38,4±6,61	18,39±2,28
Soccer	141,36±6,92	34,33±6,71	17,09±2,54
Volleyball	142,71±10,97	38,65±10,53	18,66±3,00
Swimming	141,87±8,29	35,56±7,56	17,51±2,56
Tennis	141,1±6,80	33,56±5,71	16,71±2,02
Badminton	143,78±3,54	36,18±3,73	17,55±2,24
Tae kwondo	144,76±8,32	39,82±10,69	18,73±3,06
Karate	143,13±9,10	36,28±6,59	17,62±2,12
Judo	142,20±7,94	34,49±7,10	16,93±2,20

Information: BMI (Body Mass Index*)*

The purpose of this paper is to discuss the performance specifications for the development of height and weight measuring instruments for website-based anthropometric tests, which can then be used in tests to identify children's natural ability in sports based on their anthropometric values.It is hoped that by using this tool, flaws in interpreting calculating data will be reduced thus anthropometric values appropriate for a specific sport will be analyzed. The output evaluation involves examining the sensor's characteristics, determining the tool's level of accuracy and precision, and assessing the website page used to display measurement data.

Measurement of height and weight has been attempted by a number of researchers. the first research was about created a digital height and weight measuring instrument with sound output based on the Arduino uno,The output of this research was a measuring instrument that could provide weight and height information by using the boddy mass index measurement. As a consequence, it has been running properly[5]. The other research develops an internet-based height and weight measurement method that would use a fuzzy method to provide information on child nutritional status, with the conclusion that the website could provide such information[6].

Based on previous research, the aim of this analysis is to figure out how to create a website-based method for calculating height and weight for anthropometric tests. The method produces data directly from the tool, which is then uploaded to the website. As a consequence, the risk of human error is reduced, resulting in more accurate calculation results.Furthermore, the measurement data can be analysed on the website to provide sport identification talent information.

2. Method

This research follows the principle of research and development method. Research and Development (Rnd) is a methodological approach to product research, design, manufacture, and testing[7]. Figure 1 depicts the Rnd method procedure that will be followed.

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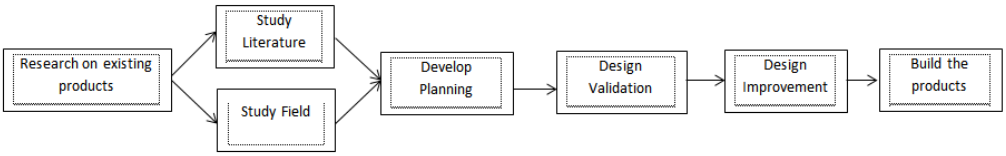

Figure 1. Procedure of research and development[7].

A literature review is carried out to technically analyze and comprehend a situation or condition with the aim of assisting in the development of height and weight measuring instruments for web-based anthropometric tests. Some literature was collected related to the study conducted by literature reviews, including literature on the process of calculating height and weight for anthropometric test with a website interface and analyses of children ability in sports based on the measures. Field studies were conducted to determine what height and weight measuring instruments could be developed and used for website-based anthropometric measurements.

Following the completion of a literature review, preparation and product development is undertaken. The block diagram in Figure 2 depicts the system design that needs to be created.

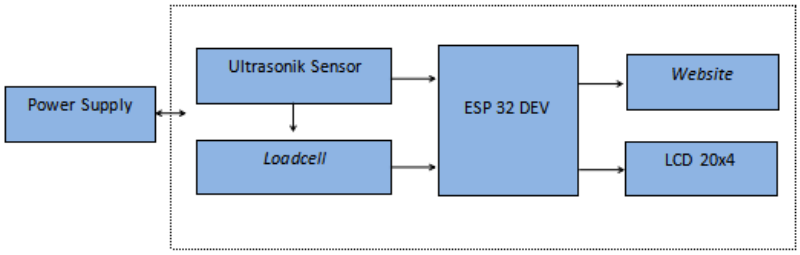

Figure 2. The System block diagram

A power supply is needed to trigger an electronic circuit, as seen in Figure 2. It needs a power supply with a voltage of 5 volts. An ESP 32 DEvKit Module micro controller controls the system. The sensor output is displayed on the LCD, and the data is then transmitted via wifi to a website dedicated to displaying talent recognition in sports. Figure 3 depicts the measuring system's flow map.

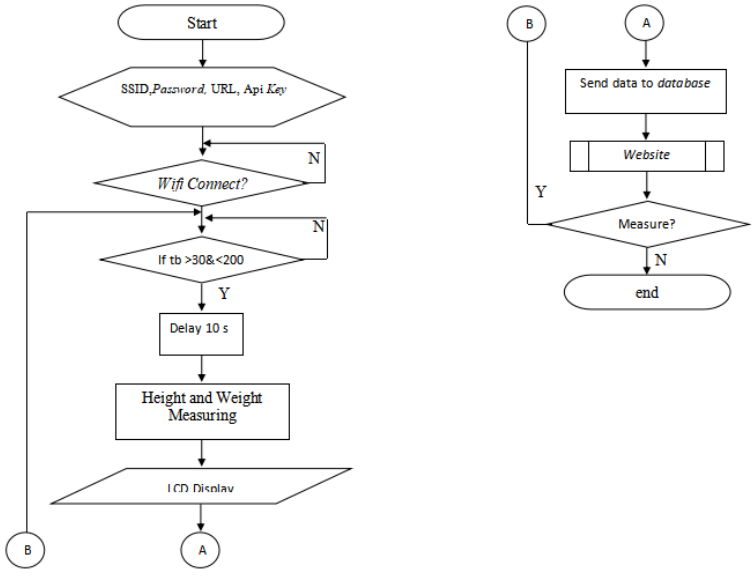

Figure 3. Flowchart of the measurement system

The ultrasonic sensor can detect whether an object has reached the sensor, as seen in Figure 3. When an object collides with the sensor, the device begins to measure distance and strain, which is then translated into height and weight. Due to taking the measurement, the output is shown on the LCD. After the data is shown, it transfers the data from the height and weight measurements to a temporary storage server through a wired wifi network. The website's flow map is shown in Figure 4.

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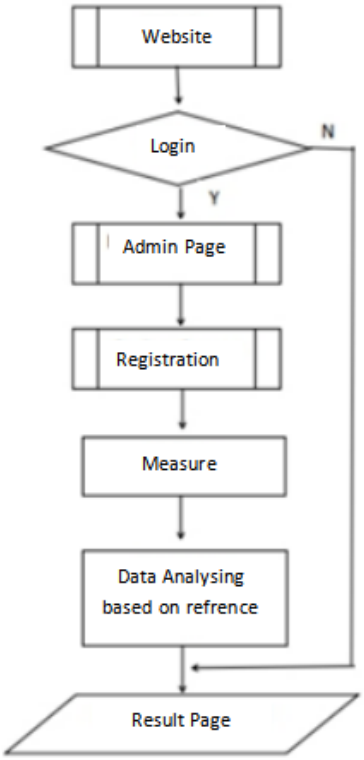

Figure 4. Flowchart of the website page

The website will view the anthropometric test calculation results page as seen in Figure 4. Data retrieval and modifications can only be made by the administrator from the website's login tab. When signing in, the administrator first inserts the participant's identity into the database server in the form of a participant number, name, origin, and age. Furthermore, through the available measuring button the admin takes measurement data from the temporary database to be entered into the database server. Simultaneously, the measurement data will be analyzed using the reference journal for anthropometric talent measures in sports. Furthermore, the information would be automatically processed and accessible to everyone at any time.

A design validation test is expected after the internal design has been planned so that the tool can proceed to the product manufacturing stage. Things are made using a manufacturing method that includes a range of supporting equipment and machinery. A mechanical system interface for the measurement process, as well as a website display of the measurement results, are among the items to be developed. Figure 5 depicts the mechanical architecture for estimating height and weight for website-based anthropometric test.

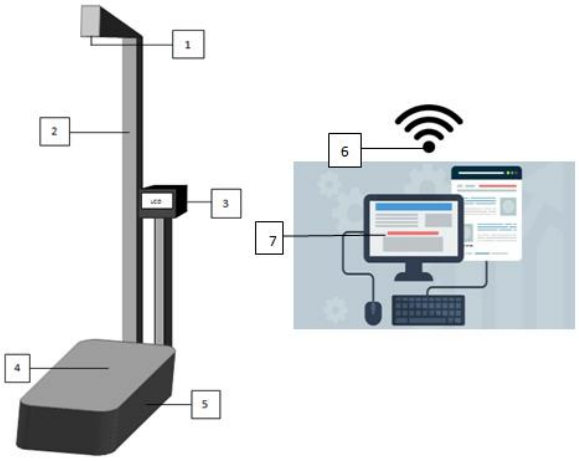

Figure 5. Mechanical architecture of measuring tools

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Based on Figure 5, it can be described that measuring tools for height and weight for website-based anthropometric tests consists of:

1. Ultrasonic Sensor
2. The ultrasonic sensor pole
3. Box of measuring instruments and LCD placement
4. Board weight support
5. Loadcell Sensor
6. Wifi network to send sensor data to the database.

Electronic components that would be required later, in addition to mechanical construction, must be built such that the height and weight measuring instruments for website-based anthropometric testing will meet the necessary purposes. Figure 6 shows the schematic circuit from body height and weight measurement tool for this website-based anthropometric test.

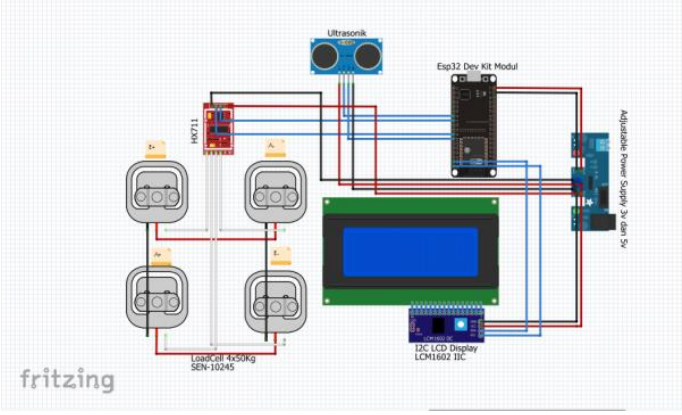

Figure 6. Schematic circuit of the tools

The Wheatstone bridge device is used to assemble the load cell sensor, as seen in Figure 6. Until the signal is processed by the microcontroller, it will be translated by the HX711 module. LCD makes use of I2C to conserve space on the micro controller's ports, and Adjustable The voltage from the power supply is reduced according to the reference value using the power supply table.

Taking some measurement data is used to verify the performance of these devices. Standard measuring instruments, such as stature meters and SNI standard scales, are used to compare the results of these measurements. Twenty samples of children aged 9 to 11 years old were used to do the measurements. This measurement is used to determine the device's accuracy. In addition, ten repeated measurements of the same object were measure to determine the device's accuracy.

3. Results and Discussion

3.1. Results

3.1.1. Specification Performance of Height And Weight For Web-Based Anthropometric Test

The functions of each part of the height and weight measurement devices for website-based anthropometric tests are included in performance specifications. Ultrasonic sensors, load cell sensors, HX711 modules, ESP 32 Dev Kit Module, LCD, and a variety of electronic components are included in this device. Figure 7 shows the shape of the measuring instrument for height and weight for website-based anthropometric tests to make it easier to understand.

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Figure 7. Instrument of body height and weight for a web-based anthropometry test

Figure 7 depicts a two-meter-high iron pole with an ultrasonic sensor acting as a height sensor. Some components of the instrument are located near the stepping board. In general, the instrument consists of a support pole with an ultrasonic sensor attached to it as a height sensor. Figure 8 depicts the ultrasonic sensor's position on the support column.

Figure 8. The position of ultrasonic sensor on the pole

The component box, as shown in Figure 9, serves as a storage area for the device builder's electronic components. The PCB (Printed Circuit Board) housing the ESP 32 Dev Kit Module, the HX711 module, and the DC-DC Converter has been assembled with these components.

Figure 9. The component box of the tools

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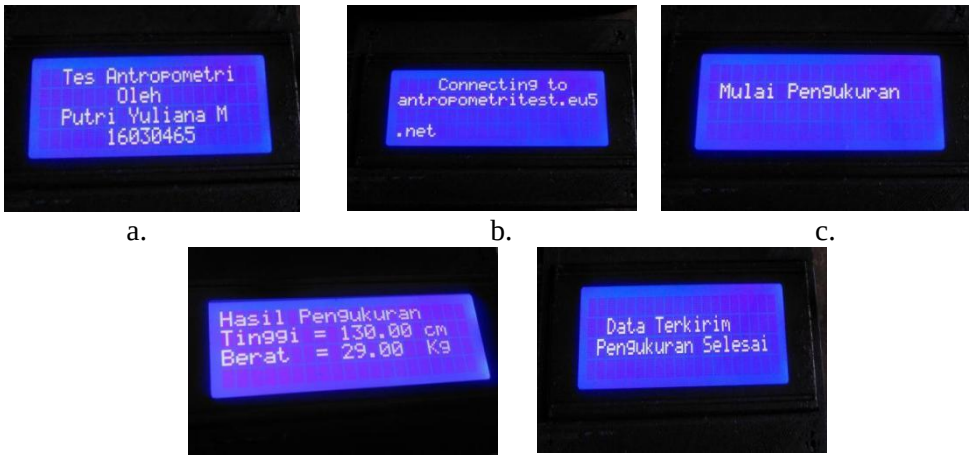
Figure 10 shows an LCD display that has been able to work according to its function and displays the process on measurement. The display on this LCD has represented a part of the system that the system has worked well. such as displaying the measurement system's flow, which begins with the initial display when the tool is switched on and continues with measurement results and indications that the system is connected to the website, as well as indicators that measurements have been completed.

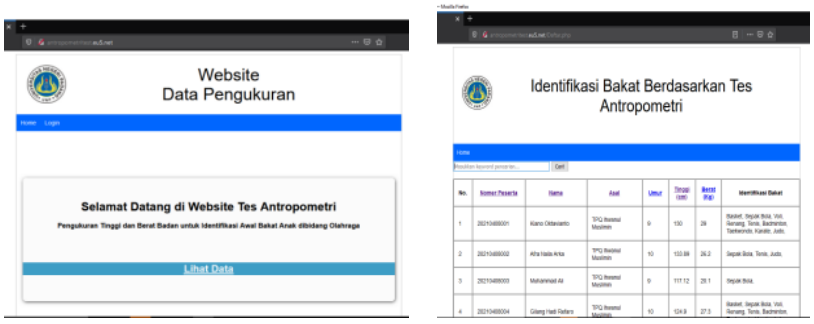


a. b. c.

d. e.

Figure 10 a. Home display, b. Connecting to website indicator display, c. Processing measurement indicator display, d. Result display, e. Data sent and finish indicator display

The website interface is the next part of this height and weight measurement system's program. The measure website can be accessed by typing http://antropometritest.eu5.net/ into a browser. The aim of the website page is to view measurement data and outcomes of talent identification in sports based on the anthropometric tests conducted. Figure 11 depicts the website page.



a. b.

Figure 11 a. Home page website, b. Result of measurement page website

3.1.2. Characterization Sensor

The ultrasonic sensor was characterized in order to see how distance affected the time it took for the wave to transmit. Measurements are taken using an oscilloscope at the output through the echo pin to determine the characteristics of the ultrasonic sensor. Figure 12 illustrates the sensor output dependent on experiment.

As seen in Figure 12a. A blue line can be shown, which is the contribution of the echo pin on the ultrasonic. When the sensor is reached by an object, the pulse width changes, according to the measurement. If the object is further away from the sensor, the pulse width will be wider; conversely, if the object is very close to the sensor, the pulse width will be smaller. An analysis was also carried out to see the relationship between time width and distance by changing the distance. In relation, in Figure 12b, a microsecond is a unit of time in the act of transmitting waves. This demonstrates how fast the method of calculating distance is. The longer the interval between the object and the sensor, the wider the wave's time width.

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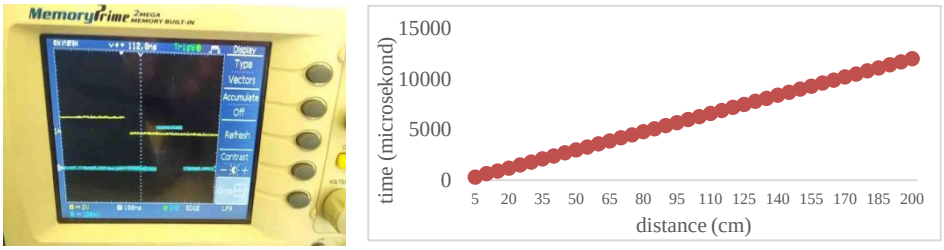


a. b.

Figure 12 a. Output of sensor ultrasonic, b. Relation of time width and the distance

The aim of the load cell sensor characterization is to see how mass changes affect the sensor output voltage. Measurements are taken at the output pin of the HX711 module, which is connected to the load cell's output cables (A + and A-), to determine the load cell's characteristics. The loadcell sensor's characteristics are shown in Figure 13.

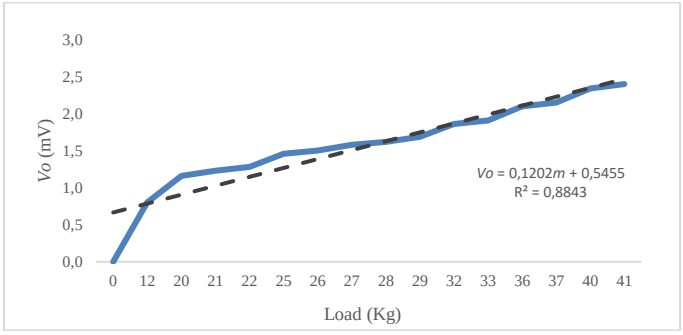
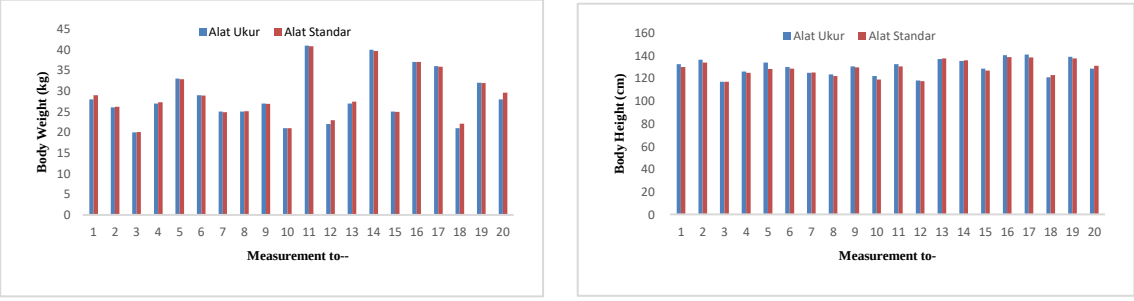


Figure 13. Relation of output voltage and the mass

Figure 13 shows the equation for the output voltage and mass relationship, $Vo = 0.1202m + 0.5255$, where Vo is the output voltage and m is the object's mass. The relationship between stress and mass is proportional, as seen in the plot. The output voltage increases as the mass increases.

3.1.3. Accuracy and Precision of the Measurement Tools

Through comparing the data read from the sensor with the results of a typical measuring instrument, such as a stature meter for height or analog scales for body mass, the measurement accuracy is determined. Formulas should be used to measure the amount of error percentage (KR percent) and accuracy (A). The data on height and weight comparisons collected from the instrument as shown in Figure 14.



a. b.

Figure 14a.The graph of comparison result of body weight, b. The graph of comparison result of body height.

The data on height and weight comparisons collected from the instrument as shown in Figure 14. The average measuring error, according to the estimates, is quite low, about 1.30 % for height and 1.35 % for body weight. The accuracy for height is 0.987 then for body weight it is 0.986. These results indicate that the measurement instrument is accurate

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The same measurement is repeated ten times with the same object to determine precision. The precision of measurements taken with measuring instruments and measurements taken with standard instruments as shown in Figure 15.

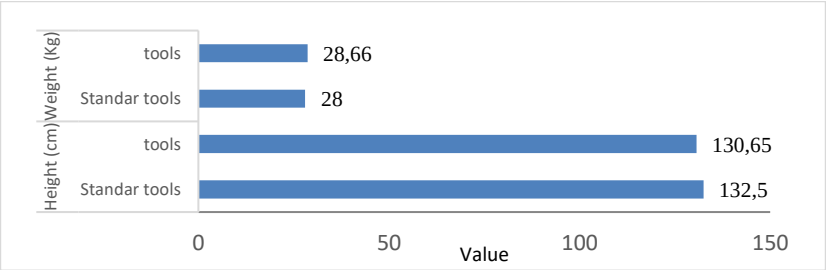

Figure 15. The comparison graph of measurement value from made tools and standard tools

As seen in Figure 15, the variation in measurement values is quite low. The proportional error for height is 1.40 %, and for body weight it is 2.60 %, according to the estimates. The precision of the instrument is 0.995 for height and 0.974 for body weight.

Using the existing specification table, the results of height and weight tests can be analysed to identify the ability by children in sport after all related data has been collected. Figure 16 depicts the results of anthropometric tests used to determine the athletic abilities of students aged 9-11 at TPQ Ihwanul Muslimin.

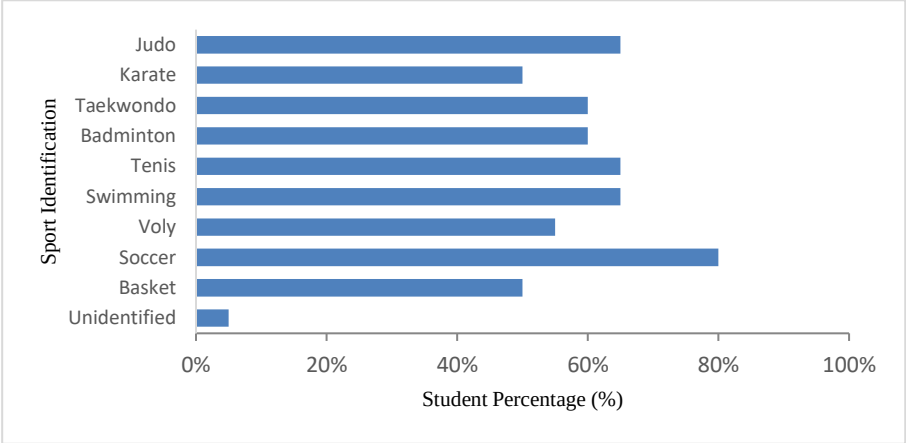

Figure 16. The result of sport talent identifying based on the anthropometric test

a student do not match the talent criteria, as seen in Figure 16. This is due to the fact that the student's anthropometric value does not match the criteria for each sport's classification value, making identification impossible.

3.2. Discussion

The information gathered are seen to be in accordance with the research objectives based on the research that was carried out, both graphically and in terms of details.The performance specifications of height and weight measuring instruments for website-based anthropometric tests, the accuracy and precision of devices, and the mapping of children's sports talent based on the results of anthropometric tests are among the result of the research.

The performance specification of the website-based height and weight measurement method is the first result of the research that has been achieved. Ultrasonic sensors, load cell sensors, ESP 32 Dev Kit Module, and LCD are among the performance specifications for measuring height and weight for anthropometric tests based on this website. It will explain the function of each component used in evaluating the results of the performance requirements from measuring tools for height and weight for anthropometric tests based on this website. The device system's electronic circuit components are housed in the component box next to the stepping board. The device efficiency specifications have yielded positive results[8]. Since, when viewed from the aspect of stability, the

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device has shown consistency between input and output. Furthermore, the system has a good transient response, as shown by the system's output in units of time at the time of the transition phenomenon.

Ultrasonic sensor is given a trigger pulse in the form of 5 V input voltage, the sensor emits ultrasonic waves that are used to perform the measurement operation[9]. According to the experiment, when the sensor is triggered, the sensor is able to emit and recapture waves, which triggers the measurement process. This indicates that the sensor is in good condition. Furthermore, load cell sensor calibration entails examining the load cell sensor's characteristics and calibrating the load cell sensor.This is done in order to provide a base for using sensors and to measure the accuracy of the sensors used in the instrument. The electrical properties of the sensor were examined during the study, specifically the relationship between load and the resulting output voltage. A linear relationship between the two variables was discovered after the measurements were taken. It's reasonable to assume that the sensor is still working[10].

Futhermore, to take measurements using tools to see the value of measurement accuracy and precision. Each measurement will inevitably produce an error or measurement error. This can happen due to limited tools, environmental factors, or there are errors in making measurements. Repeated measurements are needed to ensure that the errors obtained are not excessive[11]. The relative error size in the accuracy calculation is 1.3 % for height and body weight is 1.35 %, while the measurement of the relative error in the precision measurement is 1.4% for height and body weight is 2.6%. More over by comparing the results of device measurements with theoretical calculations by making repeated measurements, a good measuring instrument has an accuracy of close to 1 or 100 %[12]. As a result, the accuracy value of the height and weight measuring instrument for this website-based anthropometric test is similar to one, and the accuracy value is close to the value of the measurement using standard instruments.

The final research result is to analyze the measurement results of identification of children's sports talent through a website. Based on research published in the journal of Katrijn, et al. (2015), who were successful in mapping the talents of children (9-11 years) in sports using a variety of measures, one of which was the anthropometric test. The website that has been developed can be used to identify talents. The results of anthropometric tests will be compared to the anthropometric reference values for each sport (can be seen in Table 1). The talents of 19 samples can be identified based on the measurement tests, although one sample cannot be identified. This is because the sample's anthropometric values do not match into any of the current sports categories. Overall, the website was successful in achieving its objectives, which included showing measurement results and identifying talents based on the anthropometric values obtained.

4. Conclusion

Based on research, it concludes that instruments for height and weight for website-based anthropometric tests are accurate and precise. Data transfer from the device to the website database is available. The use of the website as an interface has allowed for the provision of information about the talents possessed based on anthropometric values. The limitation of this research is that identifying sports talents is less precise because several parameters are needed in addition to the anthropometric test. To identify talent in sports, it is important to combine data from other test results.

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